HR-212 Suitability of Treating Iowa Marginal Aggregate and Soils by Foamix Process

Key Words: Aggregate, Foamix, Soils, Foamed Asphalt

ABSTRACT
Quality granular materials suitable for building all-weather roads are not uniformly distributed throughout the state of Iowa. For this reason the Iowa Highway Research Board has sponsored a number of research programs for the purpose of developing new and effective methods for making use of whatever materials are locally available. This need is ever more pressing today due to the decreasing availability of road funds and quality materials, and the increasing costs of energy and all types of binder materials.

In the 1950s, Professor L. H. Csanyi of Iowa State University had demonstrated both in the laboratory and in the field, in Iowa and in a number of foreign countries, the effectiveness of preparing low cost mixes by stabilizing ungraded local aggregates such as gravel, sand and loess with asphalt cements using the foamed asphalt process. In this process controlled foam was produced by introducing saturated steam at about 40 psi into heated asphalt cement at about 25 psi through a specially designed and properly adjusted nozzle. The reduced viscosity and the increased volume and surface energy in the foamed asphalt allowed intimate coating and mixing of cold, wet aggregates or soils. Through the use of asphalt cements in a foamed state, materials normally considered unsuitable could be used in the preparation of mixes for stabilized bases and surfaces for low traffic road construction. By attaching the desired number of foam nozzles, the foamed asphalt can be used in conjunction with any type of mixing plant, either stationary or mobile, batch or continuous, central plant or in-place soil stabilization.

The extensive laboratory and field tests conducted at Iowa State University disclosed a number of advantages of the foamed asphalt process, including the following:

- Ungraded local aggregates may be used in producing satisfactory mixes for paving purposes.
- Cold, damp or wet aggregates may be used in the production of cold mix asphaltic concretes.
- Clayey, sandy or granular soils may be stabilized in a moist condition with asphalt cements by either stationary plants or mobile road mix plants.
- Asphalt concrete mixes can be stockpiled for long periods of time.

In 1968, the patent rights for the Csanyi process were acquired by Mobil of Australia. By 1970 Mobil had modified the process for foaming by replacing the steam with 1-2% cold water and further allowing mixing of the foam through a suitable mixing chamber. Mobil was granted a patent in Australia in 1971 and the patent has now been extended to at least 14 countries; some type of work related to foamed asphalt is being performed in at least 16 countries. In the U.S., Conoco, Inc., has the rights to the foam process.

The basic Mobil foaming process consists of introducing cold water under controlled flow and pressure into hot asphalt cement in a specially designed foaming chamber which discharges the foamed asphalt into the cold, moist aggregate through the nozzles of a spray bar.

Objectives

It was envisioned that the research of foamed asphalt would be conducted in two phases. Phase 1 consists of laboratory evaluation of marginal materials and Phase 2 will be one or more field trials to gain experiences associated with foamed asphalt construction, control, performance and to establish mix design criteria suitable for Iowa conditions. The objectives of Phase 1 were to investigate, in the laboratory with a Mobil/Conoco Foaming Unit, the suitability of:

1. Representative marginal but locally available Iowa aggregates and soils as foamed asphalt stabilized base courses,
2. Cold mix recycling by foamed asphalt process, and
3. Stabilizing materials present on country roads (gravels and rocks) by the foamed asphalt process.

Within the scope of this study and on the basis of materials evaluated, the following conclusions can be drawn:

1. Of eight materials tested, five can be designed by foamed asphalt process to meet either Hubbard-Field or Marshall criteria as suggested by Professor Csanyi. A sixth material (Shelby blow sand), because of lack of fines, can be successfully stabilized with foamed asphalt when blended with 10% loess.
2. As much as 40% loess can be utilized in conjunction with fine sand in foamed stabilized mixes.
3. No apparent differences could be detected between Csanyi's steam foam asphalt and asphalt foamed by Mobil's cold water process.
4. Mixing moisture content in the soil aggregate is the single most important factor in foamed asphalt mix design. Proper pre-mix moisture makes intimate mixing and better distribution of foamed asphalt possible and results in better compacted density and stability.
5. The optimum mixing moisture content varies with types of materials (percent passing No. 200 sieve), ranging from 65% to 85% of optimum moisture content determined by AASHTO T99.
6. In 8 of 11 comparable mixes, foamed mixes had equal or higher Marshall stabilities than corresponding hot mixes of same aggregate, asphalt type and content. Only for aggregates B-3, B-5 and C-1 did hot mixes have higher stabilities than comparable foamed mixes.
7. No appreciable differences were found between foamed mixes made with AC-10 and 200/300 penetration asphalt cements.
8. Foamed asphalt cold mixes generally had low compacted densities, high voids and low resistance to water action as measured by Marshall stabilities after 24 hour immersion in water at 140°F.

9. Although gradation of sand is not critical to stabilization by foamed asphalt, addition of small amounts of fines (10 to 20%) to clean sand greatly improved the stability of the foamed mixes. This could be seen by comparison between B-3 and B-6, and between B-2 and B-8 at 4% foamed asphalt.
10. Although materials containing as much as 65% passing No. 200 sieve had been successfully stabilized by foamed asphalt, the realistic upper limit of percent passing No. 200 sieve is perhaps in the range of 35-40%. Limited data also showed that percent fines (passing No. 200 sieve) is more important in judging the suitability of stabilization by foamed asphalt than plasticity index of the fines.
11. Marshall flow values of foamed asphalt cold mixes are not sensitive to asphalt content variations.
12. While no curing is required before compaction, foamed asphalt stabilized mixes do need curing to improve coating and to develop strength.
13. Within half-life of 10 to 140 seconds and foam ration of 5 to 20, no differences could be detected in the properties of resulting foam mixes.
14. Upgrading existing county road surfaces material by foamed asphalt is possible provided that the percent passing No. 200 sieve is not excessively high.
15. Cold mix recycling by foamed asphalt process is feasible provided that the mix design is based on cold mix recycling concept.
16. The addition of small amounts of either hydrated lime or Portland cement improves the resistance to water action of a foamed mix.
17. Because of the effect of curing on the strength development of the foamed mixes, foamed mix design procedure and criteria should be locally based. These design criteria can be best established on the basis of laboratory-field correlations obtained from the field trials.